CLAIMS:

1. A method of detecting an envelope of an audio signal comprising the steps of:

filtering the audio signal to produce a filtered audio signal;

rectifying the filtered audio signal to produce a rectified signal;

detecting peak values of the rectified signal to produce a detected signal;

sampling the detected signal at predetermined time intervals to produce samples; and

resetting the detected signal immediately after sampling.

2. A method of detecting an envelope of an audio signal comprising the steps of:

filtering the audio signal into multiple filtered audio signals;

rectifying each of the mutiple filtered audio signals into respective multiple rectified signals;

detecting peak values of each of the multiple rectified signals to produce detected signals;

sampling each of the detected signals at predetermined time intervals to produce samples; and

resetting each of the detected signals immediately after sampling.

3. A method according to claim 1 or claim 2 wherein the rectifying step uses half wave rectification.

4. A method according to claim 1 or claim 2 wherein the rectifying step uses full wave rectification.

5. A method according to any one of claims 1 to 4 wherein the detected peak values remain at a substantially constant value prior to the sampling step.

6. A method according to claim 5 wherein the detected signal or detected signals is reset substantially to zero.

7. A method according to any one of claims 1 to 6 wherein the sampling rate used in the sampling step is relatively low compared to frequency components in the filtered audio signal.

8. A method according to any one of claims 1 to 7 wherein the audio signal is input to a cochlear implant device.

9. Apparatus for detecting an envelope of an audio signal comprising:

means for filtering the audio signal to produce a filtered audio signal;

means for rectifying the filtered audio signal to produce a rectified signal;

means for detecting the peak values of the rectified signal to produce a detected signal;

means for sampling the detected signal at predetermined time intervals to produce samples; and

means for resetting the means for detecting immediately after sampling, such that the detected signal is reset immediately following sampling.

10. Apparatus for detecting an envelope of an audio signal comprising:

means for filtering the audio signal into multiple filtered audio signals;

means for rectifying each of the multiple filtered audio signals into respective multiple rectified signals;

means for detecting the peak values of each of the multiple rectified signals to produce detected signals;

means for sampling each of the detected signals at predetermined time intervals to produce samples; and

means for resetting the means for detecting immediately after sampling, such that each of the detected signals are reset immediately following sampling.

11. Apparatus according to claim 9 or claim 10 wherein the means for rectifying is one or more full wave rectifiers.

12. Apparatus according to claim 9 or claim 10 wherein the means for rectifying is one or more half wave rectifiers.

13. Apparatus according to any one of claims 9 to 12 wherein the detected peak values remain at a substantially constant value prior to sampling.

14. Apparatus according to claim 13 wherein the detected signal or detected signals is reset substantially to zero.

15. Apparatus according to any one of claims 9 to 14 wherein the sampling rate used by the means for sampling is relatively low compared to frequency components in the filtered audio signal.

16. Apparatus according to any one of claims 9 to 15 wherein the audio signal is input to a cochlear implant device.

17. A method of enhancing the pitch cue of an audio signal perceived by a cochlear implant recipient, wherein the audio signal is processed and input to an implant device of the recipient, the method comprising the steps of:

filtering the audio signal to produce a filtered audio signal;

half-wave rectifying the filtered audio signal to produce a half-wave rectified signal; and

sampling the half-wave rectified signal at predetermined time intervals.

18. A method according to claim 17 wherein the sampling rate used in the sampling step is relatively high compared to the frequency components in the filtered audio signal.

19. A method according to claim 18 wherein the sampling rate is at least eight times the highest frequency component in the filtered audio signal.

20. Apparatus for enhancing the pitch cue of an audio signal perceived by a cochlear implant recipient, the audio signal being processed and input to an implant device of the recipient, the apparatus comprising:

means for filtering the audio signal to produce a filtered audio signal;

means for half-wave rectifying the filtered audio signal to produce a half-wave rectified signal; and

means for sampling the half-wave rectified signal at predetermined time intervals.

21. Apparatus according to claim 20 wherein the sampling rate used in the sampling step is relatively high compared to the frequency components in the filtered audio signal.

22. Apparatus according to claim 21 wherein the sampling rate is at least eight times the highest frequency component in the filtered audio signal.

23. A method of enhancing the pitch cue of an audio signal perceived by a cochlear implant recipient, wherein the audio signal is processed and input to an implant device of the recipient, the method comprising the steps of:

filtering the audio signal to produce a filtered audio signal;

half-wave rectifying the filtered audio signal to produce a half-wave rectified signal;

detecting the peak values of the half-wave rectified signal and resetting the detected peak values to produce a reset detected signal; and

sampling the reset detected signal at predetermined time intervals.

24. Apparatus for enhancing the pitch cue of an audio signal perceived by a cochlear implant recipient, the audio signal being processed and input to an implant device of the recipient, the apparatus comprising:

means for filtering the audio signal to produce a filtered audio signal;

means for half-wave rectifying the filtered audio signal to produce a half-wave rectified signal;

means for detecting the peak values of the half-wave rectified signal and resetting the detected peak values to produce a reset detected signal; and

means for sampling the reset detected signal at predetermined time intervals.

25. A method of enhancing the pitch cue of an audio signal perceived by a cochlear implant recipient, wherein the audio signal is processed and input to an implant device of the recipient, the method comprising the steps of:

filtering the audio signal to produce a filtered audio signal;

envelope detecting the filtered audio signal to produce an envelope detected signal;

comparing the filtered audio signal to produce a gating signal having one of two Boolean states;

multiplying the gating signal with the envelope detected signal to produce a multiplied signal; and

sampling the multiplied signal at predetermined time intervals.

26. A method according to claim 25 wherein the envelope detecting step uses quadrature envelope detection such that the envelope detected signal is produced using in-phase and quadrature-phase filtered components of the audio signal.

27. A method according to claim 26 wherein the gating signal is produced from an in-phase filtered component of the audio signal.

28. A method according to claim 25 or claim 26 wherein the filtering step uses an in-phase filter and a quadrature filter such that the audio signal is filtered respectively into the in-phase and quadrature-phase filtered components.

29. A method according to any one of claims 25 to 28 where the sampling step is conducted at high frequencies and further comprising the steps of:

detecting peaks of and resetting the multiplied signal; and

sampling the reset multiplied signal at predetermined time intervals.

30. A method of enhancing the pitch cue of an audio signal perceived by a cochlear implant recipient, wherein the audio signal is processed and input to an implant device of the recipient, the method comprising the steps of:

filtering the audio signal to produce a filtered audio signal;

envelope detecting the filtered audio signal to produce an envelope detected signal;

comparing the filtered audio signal to produce a gating signal having one of two Boolean states;

multiplying the gating signal with the envelope detected signal to produce a multiplied signal; and

detecting the peak values of and resetting the multiplied signal to produce a peak detected and reset multiplied signal.

31. A method according to claim 30 further comprising the step of sampling the peak detected and reset multiplied signal.

32. A method according to claim 30 or claim 31 wherein the filtering step uses an in-phase filter and a quadrature filter such that the audio signal is filtered respectively into in-phase and quadrature-phase filtered components.

33. A method according to claim 32 wherein the step of envelope detecting uses quadrature envelope detection such that the envelope detected signal is based on the in-phase filtered components and quadrature-phase filtered components of the audio signal.

34. A method according to any one of claims 30 to 33 further comprising the step of applying the peak detected and reset multiplied signal to apical electrode channels and to basal electrode channels.

35. A method according to claim 34 further comprising the step of sampling at relatively high frequencies for use by apical electrode channels in order to obtain enhanced pitch cues corresponding to responses to low frequency signals.

36. A method according to claim 34 further comprising the step of sampling at relatively low frequencies using envelope detection applied to basal electrode channels corresponding to responses to high frequency signals.

37. Apparatus for enhancing the pitch cue of an audio signal perceived by a cochlear implant recipient, the audio signal being processed and input to an implant device of the recipient, the apparatus comprising:

means for filtering the audio signal to produce a filtered audio signal;

means for envelope detecting the filtered audio signal to produce an envelope detected signal;

comparator means for producing a gating signal having one of two Boolean states;

means for multiplying the gating signal with the envelope detected signal to produce a multiplied signal; and

means for sampling the multiplied signal at predetermined time intervals.

38. Apparatus according to claim 37 wherein the means for filtering uses an in-phase filter means and a quadrature filter means such that the audio signal is filtered respectively into in-phase and quadrature-phase filtered components.

39. Apparatus according to claim 38 wherein the means for envelope detecting uses quadrature envelope detection such that the envelope detected signal is produced using the in-phase and quadrature-phase filtered components of the audio signal.

40. Apparatus according to claim 39 wherein the gating signal is produced from an in-phase filtered component output from the in-phase filter means.

41. Apparatus for enhancing the pitch cue of an audio signal perceived by a cochlear implant recipient, the audio signal being processed and input to an implant device of the recipient, the apparatus comprising:

means for filtering the audio signal to produce a filtered audio signal;

means for envelope detecting the filtered audio signal to produce an envelope detected signal;

comparator means for producing a gating signal having one of two Boolean states;

means for multiplying the gating signal with the envelope detected signal to produce a multiplied signal; and

means for detecting the peak values of and resetting the multiplied signal to produce a peak detected and reset multiplied signal.

42. Apparatus according to claim 41 further comprising sampling means for sampling the peak detected and rest multiplied signal.

43. Apparatus according to claim 41 or claim 42 wherein the envelope detection means comprises quadrature envelope detection means.

44. Apparatus according to claim 43 wherein the filter means comprises in-phase filter means and quadrature-phase filter means.

45. Apparatus according to claim 44 further comprising circuit means for producing the envelope detected signal based on values of the outputs to the in-phase filter means and quadrature-phase filter means.

46. Apparatus according to claim 45 wherein an output from the in-phase filter means is input to the comparator means.

47. Apparatus according to any one of claims 42 to 46 wherein the peak detected and reset multiplied signal is applied to apical electrode channels and to basal electrode channels.

48. Apparatus according to claim 47 wherein the means for sampling samples at relatively high frequencies for use by apical electrode channels in order to obtain enhanced pitch cues corresponding to responses to low frequency signals.

49. Apparatus according to claim 47 wherein the means for sampling samples at relatively low frequencies using envelope detection applied to basal electrode channels corresponding to responses to high frequency signals.

50. A method of enhancing the pitch cue of an audio signal perceived by a cochlear implant recipient, wherein the audio signal is processed and input to an implant device of the recipient, the method comprising the steps of:

filtering the audio signal to produce a filtered audio signal; and

sampling the filtered audio signal to produce samples;

wherein the samples are synchronized with the filtered audio signal.

51. A method according to claim 50 wherein the sampling step uses a clock synchroniser that generates bursts of clock pulses separated by a fixed time interval with the leading pulse in each burst of pulses being synchronised to the phase of the filtered audio signal.

52. A method according to claim 51 wherein the leading pulse occurs at a fixed time interval after the rising zero crossing of the filtered audio signal such that only positive cycles of the filtered audio signal are sampled.

53. A method according to any one of claims 50 to 52 comprising the steps of half-wave rectifying the filtered audio signal to produce a half-wave rectified signal and sampling the half-wave rectified signal.

54. A method of enhancing the pitch cue of an audio signal perceived by a cochlear implant recipient, wherein the audio signal is processed and input to an implant device of the recipient, the method comprising the steps of:

filtering the audio signal to produce a filtered audio signal;

envelope detecting the filtered audio signal to produce an envelope detected signal; and

sampling the envelope detected signal ;

wherein the samples of the envelope detected signal are synchronised with the filtered audio signal.

55. A method according to claim 54 wherein the sampling step uses a clock synchroniser that generates bursts of clock pulses separated by a fixed time interval

with the leading pulse in each burst of pulses being synchronised to the phase of a portion of the filtered audio signal.

56. A method according to claim 55 wherein the step of envelope detecting uses quadrature envelope detection such that the envelope detected signal is produced using in-phase filtered components and quadrature-phase filtered components of the audio signal.

57. A method according to claim 56 wherein the leading pulse in each burst of pulses of the clock synchroniser is synchronised to the in-phase filtered components.

58. A method according to claim 57 wherein the leading pulse occurs at a fixed time interval after the rising zero crossing of the in-phase filtered components of the audio signal such that only positive cycles of the filtered audio signal are sampled.

59. Apparatus for enhancing the pitch cue of an audio signal perceived by a cochlear implant recipient, the audio signal being processed and input to an implant device of the recipient, the apparatus comprising:

means for filtering the audio signal to produce a filtered audio signal; and

means for sampling the filtered audio signal at predetermined time intervals to produce samples;

wherein the samples are synchronised with the filtered audio signal.

60. Apparatus according to claim 59 further comprising clock synchroniser means that inputs a clock signal to the sampling means, the clock signal comprising bursts of pulses separated by a fixed time interval with the leading pulse in each burst of pulses being synchronised to the phase of the filtered audio signal.

61. Apparatus according to claim 60 further comprising comparator means that receives the filtered audio signal and outputs to the clock synchroniser means an enabling signal representative of positive cycles of the filtered audio signal.

62. Apparatus according to claim 61 wherein the leading pulse in each burst of pulses of the clock signal occurs at a fixed time interval after the rising zero crossing of the filtered audio signal such that only positive cycles of the filtered audio signal are sampled.

63. Apparatus according to any one of claims 59 to 62 further comprising half-wave rectifying means connected between the filter means and the sampling means for half-wave rectifying the filtered audio signal to produce a half-wave rectified signal, and thereafter the sampling means sampling the half-wave rectified signal at predetermined intervals to produce samples that are synchronised with the filtered audio signal.

64. Apparatus for enhancing the pitch cue of an audio signal perceived by a cochlear implant recipient, the audio signal being processed and input to an implant device of the recipient, the apparatus comprising:

means for filtering the audio signal to produce a filtered audio signal;

means for envelope detecting the filtered audio signal to produce an envelope detected signal; and

means for sampling the envelope detected signal to produce samples;

wherein the samples of the envelope detected signal are synchronised with the filtered audio signal.

65. Apparatus according to claim 64 wherein the envelope detection means comprises quadrature envelope detection means.

66. Apparatus according to claim 65 wherein the filter means comprises in-phase filter means and quadrature-phase filter means.

67. Apparatus according to claim 66 further comprising circuit means for producing the envelope detected signal based on values of the outputs to the in-phase filter means and quadrature-phase filter means.

68. Apparatus according to claim 67 further comprising comparator means that receives an output of the in-phase filter means and outputs to a clock synchroniser means an enabling signal representative of positive cycles of in-phase filtered components of the audio signal, said enabling signal enabling the clock synchroniser means.

69. Apparatus according to claim 68 wherein the clock synchroniser means, once enabled, inputs a synchronised clock signal to the sampling means, the clock signal comprising bursts of pulses separated by a fixed time interval with the leading pulse

in each burst of pulses being synchronised to the in-phase components of the filtered audio signal.

70. Apparatus according to claim 69 wherein the leading pulse in each burst of pulses of the clock signal occurs at a fixed time interval after the rising zero crossing of the in-phase filtered output signal such that only positive cycles of the in-phase filtered components of the audio signal are sampled.

71. In a multiple channel cochlear implant system permitting sequential stimulation, a method of enhancing the pitch cue of an audio signal perceived by a cochlear implant recipient, wherein the audio signal is processed and input to an implant device of the recipient, the method comprising the steps of:

filtering the audio signal to produce a filtered audio signal;

sampling the filtered audio signal to produce samples; and

synchronising the samples of the filtered audio signal using a selection means and a series of master clock pulses, such that on each master clock pulse no more than one channel is selected by the selection means.

72. A method according to claim 71 wherein each channel has a low to high transition on a channel enable signal.

73. A method according to claim 72 wherein each channel enable signal is input to the selection means and passed through the selection means with controllable delay on each channel.

74. A method according to claim 73 where more than one channel enable signal goes high on a single master clock pulse, the method further comprises the step of selecting one channel, with the remaining channels delayed by successive master clock periods.